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MODIS Thermal Emissive Bands Calibration Algorithm and On-orbit Performance

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ABSTRACT

The MODerate Resolution Imaging Spectroradiometer (MODIS) is one of the key instruments for the NASA s Earth Observing System (EOS). MODIS ProtoFlight Model (PFM) was launched on-board the EOS Terra spacecraft on December 18, 1999 and the MODIS Flight Model (FM-1) was launched on-board the EOS Aqua spacecraft on May 4, 2002. MODIS has 36 spectral bands with wavelengths ranging from 0.41 to 14.5μm and nadir spatial resolutions of 250m (2 bands), 500m (5 bands), and 1km (29 bands). The sensor s 20 reflective solar bands (RSB) from 0.41 to 2.1μm are calibrated on-orbit by a solar diffuser (SD) and a solar diffuser stability monitor (SDSM). The other 16 thermal emissive bands (TEB) with wavelengths above 3.7μm are calibrated by a blackbody. This paper follows the discussions on the RSB calibration and instrument performance presented in a separate paper (Xiong *et. al.)* in these proceedings, and focuses on the 16 thermal emissive bands (TEB).

Keywords: Terra, Aqua, MODIS, calibration, thermal emissive bands, blackbody

1. INTRODUCTION

Following our discussions on the MODIS reflective solar bands (RSB) calibration algorithm and on-orbit performance[1] in a paper also in these proceedings, we focus on the MODIS thermal emissive bands (TEB) with wavelengths above 3.7μm. Readers are referred to the RSB paper and other references for a general review of the NASA EOS Terra and Aqua MODIS instruments and the many applications that are developed from using MODIS global data sets[2-4]. Terra MODIS (PFM) has been providing the science community and public users global data sets for the study of the land, oceans, and atmosphere for more than two and a half years in a near Sun-synchronous polar orbit of 10:30AM equator crossing time. With the recent launch of Aqua spacecraft (1:30 PM orbit), this coverage is enhanced such that the same Earth scene can be viewed both in the morning and in the afternoon. The MODIS L1B algorithm converts instrument response to the radiometrically calibrated data products (reflectance factor for the RSB, radiance for the TEB). In this paper, we discuss the TEB on-orbit calibration algorithm, its implementation strategy in the Level 1B code (L1B), and instrument on-orbit performance for the thermal emissive bands, including the differences between the Terra MODIS and Aqua MODIS.

2. THERMAL EMISSIVE BANDS AND INSTRUMENT BACKGROUND

There are 16 thermal emissive bands, covering the middle wave infrared (MWIR: bands 20-25) and long wave infrared (LWIR: bands 27-36) spectral regions. Table 1 summarizes the TEB key specification, including the spectral band center wavelength, typical scene radiance, and the corresponding noise equivalent temperature difference (NEdT). All thermal emissive bands are located on two cold focal plane assemblies (CFPAs): a short wave and middle wave infrared (SMIR) FPA and a long wave infrared (LWIR) FPA. The CFPAs are nominally controlled on-orbit at 83K using a passive radiative cooler. An on-board calibrator blackbody (BB) is used for the TEB calibration. The blackbody temperature can be varied from instrument ambient (about 270K) to 315K. Normally, it is set at 290K for Terra MODIS and 285K for Aqua MODIS. The temperature of the BB is measured by 12 thermistors embedded in the BB and is traceable to the NIST temperature scale.

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